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**Forest Service**

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# **Forestry Research West**

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U.S. FOREST SERVICE



A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

# Forestry Research West

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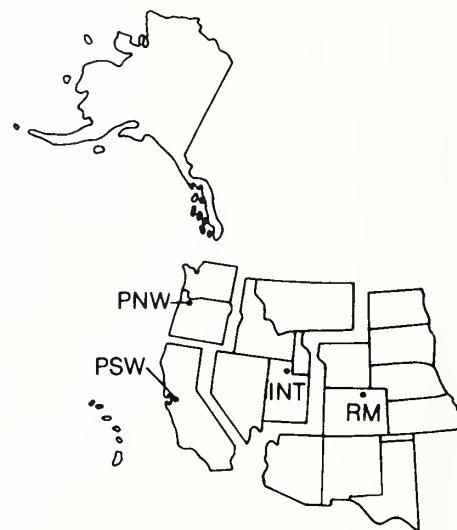
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## Cover

Aerial retardant drops are a common tool in wildfire suppression. Scientists at the Intermountain Station are working to develop ways of making its use more effective and cost efficient. Details begin on page 1.

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# How much retardant is enough?

by Mike Prouty  
Intermountain Station

My first encounter with fire retardant occurred in the summer of 1971, as I worked on a Bureau of Land Management fire crew. As a "greenhorn easterner," the rest of the crew knew I had much to learn about fighting wildfires. Building fireline on my first major fire, I heard a faint rumble. The rumble quickly grew to a roar, and I remember hearing a voice shout, "slurry drop — hit the ground!" I looked up and saw the nose of a lumbering B-17 looming at me over the horizon. A pair of hands pulled me down into the sagebrush. As the roar of engines became deafening, I squirmed face down into the rocks and sand.

It was over as suddenly as it had come. The roar of the plane was replaced by a soft sound like small flakes of wet snow hitting the ground.

*A color video camera and an infrared camera were used to record wildfires and the associated suppression efforts.*



Crawling to my feet, I discovered my hardhat and fire shirt were splattered with a red wet chalky substance, as was the sagebrush and pinyon around me. I knew then I had passed an important test — I had survived my first retardant drop. For the remainder of the summer, I proudly wore my retardant-splashed hardhat, like some campaign medal of a battle-worn veteran. And as with most fire-control folks, I harbored a strong respect, and a little fear of this powerful and somewhat mysterious element in fire control.

The use of retardant drops from aircraft on forest and range fires has long been an accepted tool in wildfire suppression. However, critics of retardant maintain its use is too indiscriminate, it is too expensive, and its effectiveness is exaggerated.

## Taking the mystery out of retardant

Scientists at the Intermountain Station's Northern Forest Fire Laboratory (NFFL) in Missoula, Montana, have been studying the use of aerial retardant for years. They have systematically evaluated the numerous factors that determine the effectiveness of retardant drops. In the 1970's, their attention was directed toward improving the "delivery systems," of retardant drops. By incorporating aero-space technology, their efforts have provided valuable information on airtanker performance, retardant tank and gating systems, and chemical properties of retardant.

An important result of this early research has been development of airtanker performance guides that provide information on specific aircraft and gating systems. To provide fire managers with a simple inexpensive reference, Forest Service scientists also devised airtanker performance "slide charts," or Retardant Coverage Computers. These charts enable fire control personnel to quickly digest a number of delivery system factors in determining the amount of retardant needed on the ground.

## Field-checking the computers

The Retardant Coverage Computers greatly improved the state-of-the-art in the use of retardants. However, their suggested retardant application rates were not verified in the field by fuel type. No one knew for sure if the amount of retardant being applied to a quickly spreading sagebrush fire was far in excess of what was needed. Similarly, was enough retardant being applied for a slow-burning fire in heavy forest fuels?

With the improved delivery system in place, Forest Service scientists have now turned their attention toward defining the amount of retardant required for a variety of fuel conditions, fire conditions, and fire suppression strategies.

According to Chuck George, project leader of the "Operational Retardant Evaluation" (ORE) study, the question, "How much retardant?" is an important one. George says fire control agencies in the United States currently use 20-25 million gallons of retardant annually in suppressing wildfires. Retardant costs alone exceed \$15 million a year. The total retardant bill, when considering delivery and base operations, ranges from \$40-50 million annually. By field-testing and refining



*Infrared photography shows the burn (white area), and two fire retardant drops, (dark black lines), intended to slow the advancing fire.*

the field guides for determining how much retardant is needed to help control a fire that is burning in a particular fuel type, the ORE project could result in substantial cost savings in fire suppression efforts.

## The study

The most acceptable way to determine the correct application rate of fire retardant is in a real fire suppression situation. However, the complexity of factors involved in fighting a wildfire is enormous. The interrelated components of fire behavior, fuel characteristics, and suppression tactics make the job of evaluating one aspect of a wildfire suppression effort a challenging task.

Project Leader George and his associates designed the study to enable them to reconstruct the entire fire control effort, as well as provide specific information on retardant effectiveness. They realized that any evaluation of retardant, to be meaningful, must be kept in the context of total control effort.

They devised a three-pronged study. A fixed-wing observer plane was equipped with a color video camera that recorded retardant drops and fire behavior. Next to the video camera an infrared camera was mounted. This camera provided a film record of ground temperatures. It enabled scientists to see through the immense clouds of smoke that so often obscure the fire's location, behavior, and effectiveness of retardant applications.

The observer plane was also equipped to record all radio transmissions on the fire. The air-to-air communication between the lead pilot, air-tanker pilots, and the air attack officer was recorded on the video tape of the fire. In addition, all ground-to-ground and ground-to-air communication was recorded. Thus, through the video film and the radio recordings, George and his group could reconstruct the total fire control effort for a particular fire.

The second leg of the project entailed instrumenting an airtanker to document the exact delivery characteristics used for a particular retardant drop. Previous delivery system research had developed the instrumentation needed to measure airtanker speed, height above ground, and the amount, rate, and pattern of retardant released. This involved use of a recording altimeter to record height above ground during the drop, and an airspeed transducer to record airspeed and tank and gating instrumentation to record exact time of release, type of drop, and time between releases. This information can then be related to drop height. From this information, performance models were developed to predict the retardant distribution on the ground.

The third prong of the study involved a "ground evaluation team." This three-person squad was air-lifted via helicopter to sites along the fireline, selected by scientists in the observer plane and cleared through the fire control organization. Once on the ground, the team collected a variety of information. They classified the fuel type, and took fuel moisture readings. They also measured the coverage of retardant by collecting samples of vegetation within a retardant drop area. These samples were later analyzed in a lab to determine the "gallons of retardant per 100 square feet." The final assessment involved fire characteristics — including the intensity of the approaching fire in terms of rate of spread and flame length. As might be expected, members of this crew needed considerable wildfire experience. At least one member of the ground team had to be qualified as a fire behavior officer.

It was now always possible for the ground team to be in place when the fire was burning. In these instances, a "post mortem" evaluation was made. In areas where retardant coverage was sufficient and stopped the advancing fire, retardant-coated fuel samples were taken and analyzed and the effective retardant coverage determined.

From these three avenues of data collection — the observer plane, the retardant airtanker, and the ground crew — George hopes to answer the question, "How much retardant is enough?"

## Putting plans into action

With research plan in hand, Project Leader George needed to identify where his operational study could be put into action. Southern California was selected. This area has some of the most severe wildfires in the nation, with associated high resource and property damage. The likelihood of the study team collecting data on numerous fires seemed assured in this fire-prone area. The area provided several major fuel types to study, had a long history of high retardant use, and offered easy logistics for the study.

So in June of 1983, in cooperation with the California Division of Forestry and the San Bernardino National Forest, the pilot ORE project was established in Hemet, California. Without their cooperation, the ORE project would never have taken place. A "command center" of sorts was established at which all involved were stationed. The observer plane was equipped and on standby. A helicopter was on contract. Three retardant airtankers were equipped with the monitoring instrumentation. And the waiting game began. Now all that was needed was a wildfire.

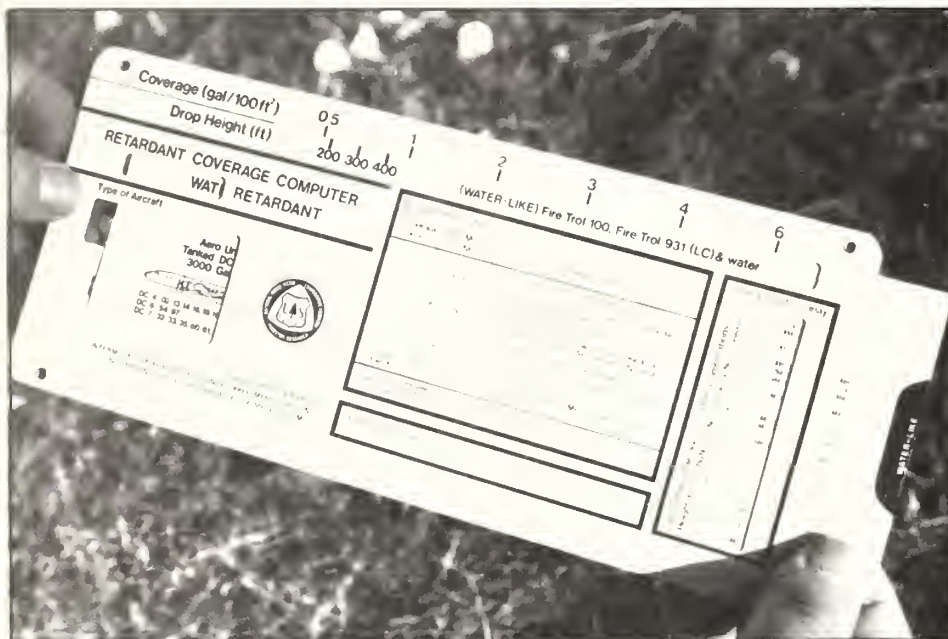
The 1983 fire season in Southern California was slow. Good news for most people, but difficult for those engaged in fire retardant research. However, through the course of that summer, the team did go on enough fires to enable them to work the bugs out of their instrumentation, and refine logistics and procedures in conducting the study. All eagerly awaited the 1984 season.

As fate would have it, the 1984 fire season in Southern California was slow again. During the 2-1/2 months the study was in progress, however, 23 fires occurred, 17 of them provided data for the ORE study.

## Initial results

Scientists involved in the ORE project are beginning to analyze the great volume of data they collected last summer. Initial results show that the Retardant Coverage Computers are in the ballpark for the fuel types tested. The application rates they suggest for light fuel seem accurate.

While the prescribed concentration of retardant appears sufficient, the ORE project revealed a weak link — involving the spacing between retardant drops as well as concentration levels within individual drops. The problem, the study found, is that most airtanker gate and delivery systems are not finely calibrated. Although the Retardant Coverage Computers may prescribe a certain drop sequence, many air tanker delivery systems do not have the accuracy and reliability to preselect the exact sequence necessary.



*Retardant Coverage Computers have enabled managers to determine the amount of retardant needed for a particular fire.*

Thus an approaching fire may burn through a retardant line, not because the prescribed retardant concentration is inaccurate, but because of gaps between drops or low concentrations of retardant within a single drop. As the technology of instrumenting airtankers becomes more widespread, scientists believe this problem will be resolved.

The 1984 field season generated additional information. The study confirmed that the safe drop heights suggested by the Retardant Coverage Computers appear accurate. This finding will likely change recommended operational safe drop heights. Also, the video and infrared photography will be valuable training tools as well as important future sources of intelligence to fire managers.

The project also increased the interest level of fire managers and air attack personnel to the research project. This interest is critical toward ensuring this new technology is applied.

## Future plans

The ORE team identified two deficiencies in the data gathered to date. Due to the slow fire seasons of 1983 and 1984, little information has been collected from high-intensity fires. Also, the initial data has been from light fuel types. "What we need now," says Project Leader George, "is to obtain data in heavy fuel types and during high-intensity fires."

The Project Leader hopes to extend his research to other locations across the country, to verify and refine retardant coverage rates in a variety of fuels and fire situations. "The more situations we can verify, the more powerful the tool becomes to managers," says George.

By answering the question, "How much retardant?" the ORE project can prescribe modifications to delivery systems and retardant chemistry. Information from the study can be used to formulate better methods of selecting airtankers, allocating them to dispatch centers, and dispatching them to fires. Presently airtankers simply take turns being dispatched to fires. As research develops criteria matching optimum airtanker delivery systems with fire types, dispatchers will be able to select the best airtanker for the fuel or fire situation.

Through the research efforts of Forest Service scientists at the Forest Fire Lab in Missoula, Montana, the use of retardant will become a more cost efficient and effective tool in controlling wildfires.

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# SOLPLOT: An aid to controlling sunlight and shade

by J. Allan Wagar  
Pacific Southwest Station

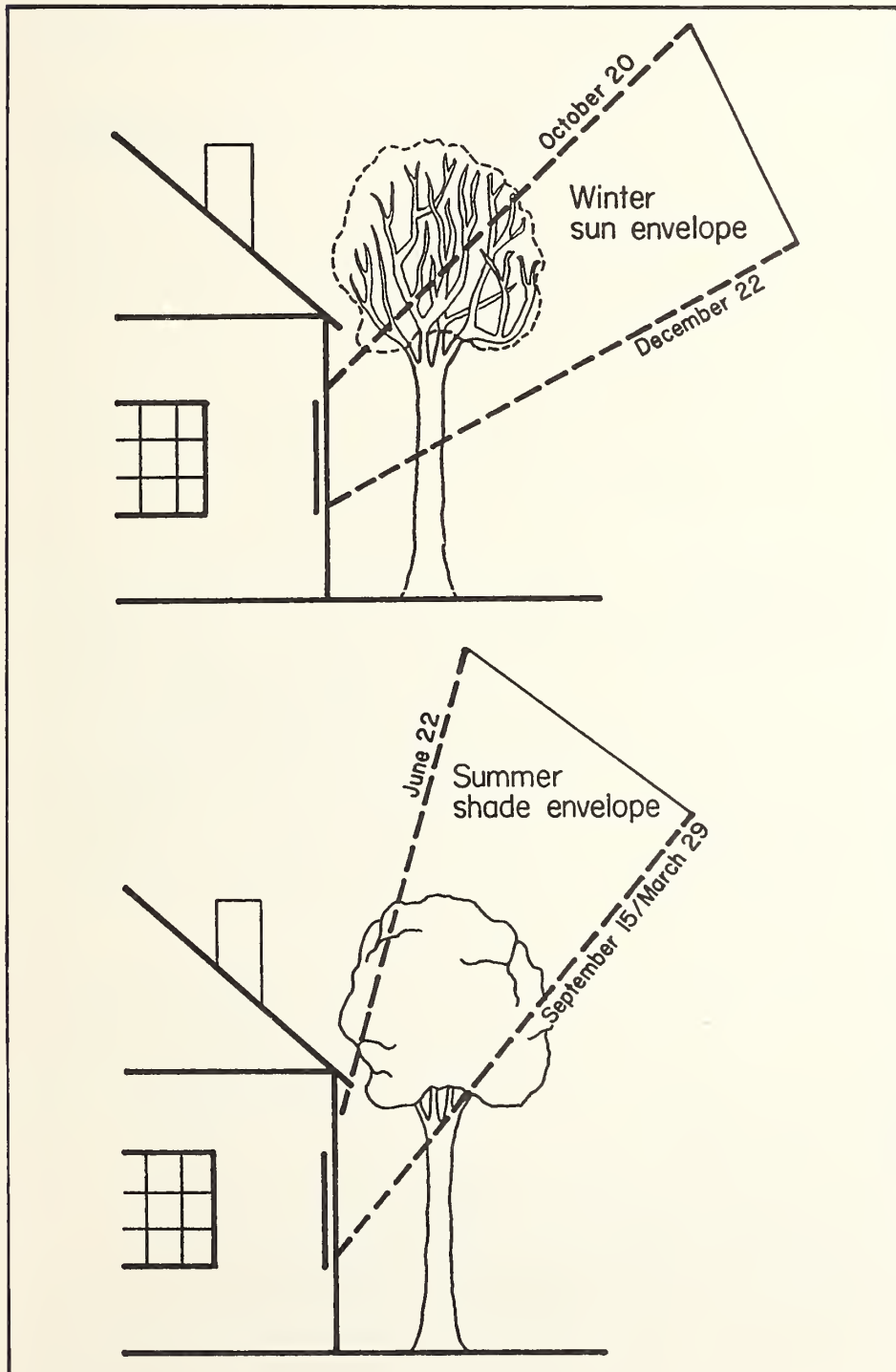
Landscape architects, arborists, homeowners, and others have long used trees to control sunlight and

shade. Control is especially desirable for windows. Designing for such control, however, requires analysis of the boundary between sunlight and shade on four specific dates: the summer and winter solstices, the last summer or early autumn date on which full shade is desired, and the first autumn date on which full sun is desired.

Plotting a position for vegetation that will shade a specific point at a specific moment is quite simple. But integrating such information for a whole canopy and across windows of various dimensions and orientations for various latitudes, seasons, and times of day is both complex and repetitive. Computers, however, are ideal for doing repetitive computations. Scientists in the Landscape and Urban Forestry research unit at the Pacific Southwest Station, therefore designed the SOLPLOT computer program especially to guide the placement of trees to control sunlight and shade on windows. But SOLPLOT can also be used to analyze control by structures or to control sunlight and shade on solar panels, patios, swimming pools, and other features.

SOLPLOT is "user friendly" and is available for either large computers or microcomputers. When prompted by the program, the user simply enters latitude, the dimensions and orientation of the window (or other feature) of concern, and the dates and times at which sunlight or shade is wanted in specific positions.

*Cross-sectional views made from the contour map (page 6) show the summer shade and winter sun envelopes directly south of the window. To judge the effects of vegetation in various positions, cross sections can be constructed at various directions from the window.*



0, HT TO TOP OF WINDOW 6 0

OM WINDOW CONSIDERED, 40.

CANOPY HT (IN FEET) TO TOP OF CANOPY	SHADE FROM 500 TO 1900	SHADE FROM 600 TO 1800	SUN FROM 800 TO 1700	SUN FROM 900 TO 1600
0	0	0	0	0
1	10	5	2	1
2	20	10	4	2
3	30	15	6	3
4	40	20	8	4
5	50	25	10	5
6	60	30	12	6
7	70	35	14	7
8	80	40	16	8
9	90	45	18	9
10	100	50	20	10
11	110	55	22	11
12	120	60	24	12

10

LAT = 38 0, WIDTH OF WINDOW 9 0, HT TO BOTTOM OF WINDOW 2 0, HT TO TOP OF WINDOW 6 0  
SMALLEST ELEVATION ANGLE CONSIDERED, 5. (CLOSEST ANGLE FROM WINDOW CONSIDERED, 40  
2CONTOURS PER DATE

DATE FOR SHADE OVER CANOPY	6 22 (DATE 1)	0 = MINIMUM HT (IN FEET) TO TOP OF CANOPY	SHADE FROM	500 TO 1900
LAST AUTUMN DATE FOR FULL SHADE.	9 15 (DATE 2)	+ = MAXIMUM HT (IN FEET) TO BOTTOM OF CANOPY	SHADE FROM	600 TO 1800
EARLIEST AUTUMN DATE FOR FULL SUN.	10 20 (DATE 3)	- = MINIMUM HT (IN FEET) TO BOTTOM OF CANOPY	SUN FROM	800 TO 1700
DATE SUN DESIRED OVER CANOPY.	12 22 (DATE 4)	* = MAXIMUM HT (IN FEET) TO TOP OF CANOPY	SUN FROM	900 TO 1600

```

              X
    175 DEGREES      X
XXXXXXXXXXXXXXXXXXXXX
              X
              X

```

0 5 10  
SCALE 1 INCH = 3.33 FEET

```

) x solplot ..... Calls program

Solar Plot - Interactive Version.
Would you like a heading message?
y ..... For yes

Enter Header - 64 chars/line, 8 lines max. End with @
Plot for south window of Jones residence 4/12/84
215 Pleasant Lane
@

1. LATITUDE FOR WHICH YOU ARE PLANNING (DEG.)
37.3

2. DIRECTION WINDOW FACES (DEGREES CLOCKWISE FROM N.)
163

3. WIDTH OF WINDOW (FT.)
9

4. HEIGHT OF WINDOW (FT.)
4.2

5. DISTANCE FROM GROUND TO BOTTOM EDGE OF WINDOW (FT.)
3.3

6. MINIMUM ELEV. ANGLE TO CONSIDER (DEFAULT=5 DEG, 0 FOR DEFAULT)
0

7. MINIMUM ANGLE FROM WINDOW (DEFAULT=20)
0 ..... 0 for default

CHANGE ANY ITEM BETWEEN 1 AND 7? (0 TO CONTINUE)
0 ..... 0 or "return" to continue;
number of item to change

DEFAULT VALUES FOR DATES AND TIMES
DATE    HOURS    DESIRED EFFECT
1. 6 22 0500-1900  FULL SHADE FROM TOP OF CANOPY
2. 9 15 0600-1800  LAST DATE, FULL SHADE FR BOTTOM OF CANOPY
3. 10 20 0800-1700 FIRST DATE, FULL SUN UNDER CANOPY
4. 12 22 0900-1600  FULL SUN OVER CANOPY
DATES TO SKIP? (UP TO 3. ONE CHARACTER/DATE)
13 ..... Skips dates 1 and 3

2. LAST DATE FOR FULL SHADE FROM BOTTOM OF CANOPY
MONTH? 9 ..... Entering month elicits
DATE? 5 additional prompts
FROM? 700 TO? 1830

4. DATE FOR FULL SUN OVER CANOPY
MONTH? ..... 0 or "return" for default

CHANGE ANY ITEM BETWEEN 1 AND 4 (0 TO CONTINUE)

```

SOLPLOT prompts the user for needed information. Typical responses are underlined.

Analyzing the east, west, and south windows of a home with SOLPLOT provides a basis for designing a complete landscape but still requires professional judgment and skill. For example, tall trees some distance from a window create some of the same effects as shorter trees closer to a window. Landscapes designed with assistance from SOLPLOT can maximize control of sunlight and shade on windows, solar panels, and other features and can provide substantial energy savings.

Program listings in both FORTRAN 77 and Microsoft BASIC, along with user instructions, are available from the PSW Station.

Note:

THE AUTHOR: J. Alan Wagar is project leader of the Landscape and Urban Forestry Research Unit at the Pacific Southwest Station. This article is a modified version of an article published in the *Landscape Journal*, 3(1):24-35, entitled "Using Vegetation to Control Sunlight and Shade on Windows."

by Rick Fletcher  
Rocky Mountain Station

Our nation's wildlands provide a wide variety of tangible values such as timber, range, and mineral products. They also offer, in some combination, the intangibles — habitat for wildlife, educational and spiritual retreats for people, scenic beauty, and recreational experiences, to name a few. Legislation such as the Resources Planning Act of 1974 requires that a dollar value be assigned to not only the tangible benefits, but the intangibles as well, to help resource specialists make land management decisions.

Scientists at the Rocky Mountain Station are working to develop and verify modeling concepts and methods that will help determine values for such intangible benefits. George Peterson, Project Leader for the Valuation of Wildland Resource Benefits Project at Fort Collins,

Colorado, says that his unit is taking a four-fold approach. They are working to:

- 1) develop a better understanding of the concepts of valuation, and more acceptable means of jointly valuing benefits from the same resource base;
- 2) define recreation benefits and measure their value in comparison with values realized from alternative uses;
- 3) develop ways to identify and measure the full range of values associated with water, and then integrate this information into wildland planning and management decisions; and
- 4) establish ways to value benefits associated with priced commodities that are not included in, or reflected by, pricing mechanisms.

*Researchers are working to place a dollar value on recreational experiences such as fishing and canoeing.*



Some of the unit's early efforts focused on defining the term "value" as it relates to wildland resource benefits. This involved developing a better understanding of valuation theories and methods. Three new reports, available from the Rocky Mountain Station help sum up this work:

"The Concept of Value in Resource Allocation", by Thomas C. Brown, a reprint from *Land Economics*, Volume 60, No. 3.

*Emperical Estimates of Amenity Forest Values: A Comparative Review*, General Technical Report RM-107, by Cindy F. Sorg and John B. Loomis.

"Comparability of Market Price and Consumer Surplus for Resource Allocation Decisions", by Donald H. Rosenthal and Thomas C. Brown, a reprint (in press) from the *Journal of Forestry*.

## Benefit Studies

Several studies have helped scientists better understand the concepts of resource valuation. For instance, one recent undertaking analyzed the economic values placed on hunting and fishing experiences in Idaho. Surveys measured the benefits to hunters and anglers of their outdoor experiences and their willingness to pay over and above actual cash expenditures. Values were highest for activities associated with relatively unique species, such as mountain goat and bighorn sheep, and lowest for generally available activities such as upland game hunting and warm water fishing.



"If this is any indication of a trend," says Peterson, "and we believe that similar results would be found nationwide, it shows that the magnitude of consumer surplus values corresponds with the relative scarcity of the opportunity to hunt or fish for particular species."

Another study has just been completed on the value of firewood collecting. Researchers wanted to know how much people were willing to pay for the wood itself. But even more important was data on their willingness also to pay for the experiences of being partly self-sufficient, being in the woods, getting exercise, being with family or friends, leaving the city, or trying something new.

*The value of big game hunting is just one of the many benefits enjoyed by hunters throughout the U.S.*

The study used regression analysis to estimate a relationship between (1) the number of permits sold in a given market area, and (2) the price of the firewood cutting experience (i.e. \$15 permit fee, plus mileage and time charges for travel). By using a travel cost model (based on the fact that the number of times a person visits a forest site is inversely related to the person's distance from the site), scientists developed an estimate of the public's willingness to pay for access to the firewood. Dividing this number by the total number of cords harvested at the site gives the average dollar amount a person is willing to pay for obtaining a cord of firewood.



In addition to seeing the woodpile grow, firewood gatherers claim that other benefits such as being outdoors, getting exercise, and being with family and friends are also important.

This particular study was conducted for a fuelwood area near Denver, Colorado. The analysis indicates an average willingness to pay \$22.64 per cord for small live lodgepole pine stumpage. These data help forest managers measure the value to consumers of the fuelwood experience, and how it compares to the value of other wildland benefits.

Results are also in on a study conducted recently in northern Arizona. The research helped scientists develop statistical models that predict how the public perceives forest scenic beauty.

By showing slides of forest scenes to visitor panels, scientist found that herbage and large ponderosa pine were viewed as attractive, while thick stands of small and intermediate-sized trees and downed wood,

especially slash, detract from scenic beauty. Observers preferred areas of lower overstory density and less tree clumping.

"Scenic beauty models such as these are well suited for use in forest planning," said Peterson. The models should complement use of the Visual Management System and enhance the landscape architect's ability to manage scenic beauty.

"The bottom line to our research" says Peterson, "is to provide a way of determining what the public feels are the most important products and benefits our nation's wildlands can provide. The results then help resource specialists manage accordingly. Models developed from this research may be applicable for other geographic areas — that is yet to be tested. I do know, however, that the methods we use in our studies can certainly be applied to develop valuation models elsewhere," he said.

If you would like to read more about this research, the following are suggested (available from the Rocky Mountain Station, unless otherwise noted).

*Monetary Valuation of Timber, Forage, and Water Yields from Public Forest Lands*, General Technical Report RM-95, by Thomas C. Brown.

*Valuation of Wildland Resource Benefits*, edited by George L. Peterson and Alan Randall, (available from Westview Press, Boulder, Colorado).

"Travel Cost Models, Heteroskedasticity, and Sampling," by D.H. Rosenthal and J.C. Anderson, in *Western Journal of Agricultural Economics*, Vol. 9, No. 1.

*The Travel Cost Model: Concepts and Applications*, General Technical Report RM-109, by D.H. Rosenthal, J.B. Loomis, and G.L. Peterson.

"Benefit and Value Estimation," by B.L. Driver, in *Outdoor Recreation Management*, 2nd Edition, Section 95, (available from John Wiley and Sons, New York, New York).

"Some Concerns About User Fees for Public Outdoor Recreation Areas," by B.L. Driver, in *American Forests*, Vol. 90, No. 3 (not available from Rocky Mountain Station).

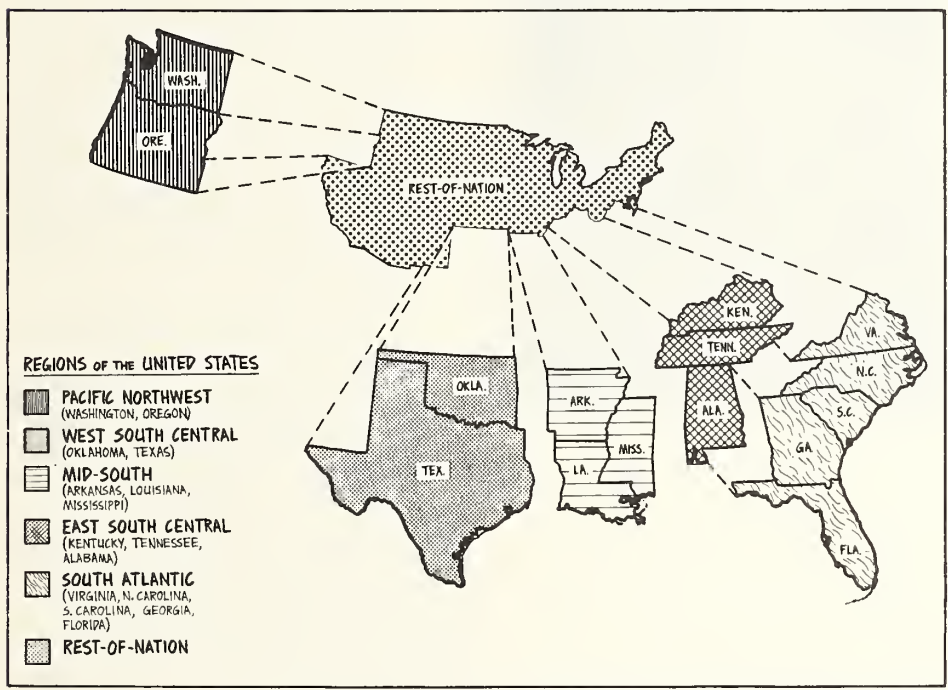
*Modeling Forest Scenic Beauty: Concepts and Application to Ponderosa Pine*, Research Paper RM-256, by Thomas C. Brown and Terry C. Daniel.

# 245 An economist tracks shifts in the timber industry

by Dorothy Bergstrom  
Pacific Northwest Station

Announcements of sawmill and plywood plant closures in Oregon and Washington usually imply that high mortgage rates and the slowdown in homebuilding are to blame. "But that's only partly true," says Con Schallau, a forest economist at the Pacific Northwest Station. "Even when the housing market recovers from the current slump we will find that the Pacific Northwest has lost some of its timber processing capacity."

The change has been significant, according to Schallau. Employment changes have not been confined to job losses at local mills; they have also affected corporate offices. In recent years, for example, the Georgia-Pacific Corporation has moved its national headquarters from Oregon to Georgia and the Boise Cascade Corporation has announced plans to transfer regional marketing activities from Portland to its headquarters in Boise, Idaho. The Pacific Northwest's forest products industry probably suffered more during the 1980-82 downturn than other segments of industry, which was not the case during other recessionary periods since World War II. "The truth is that the industry in Oregon and Washington is undergoing a fundamental change that has little to do with short-term fluctuations in the Nation's economy," he says.



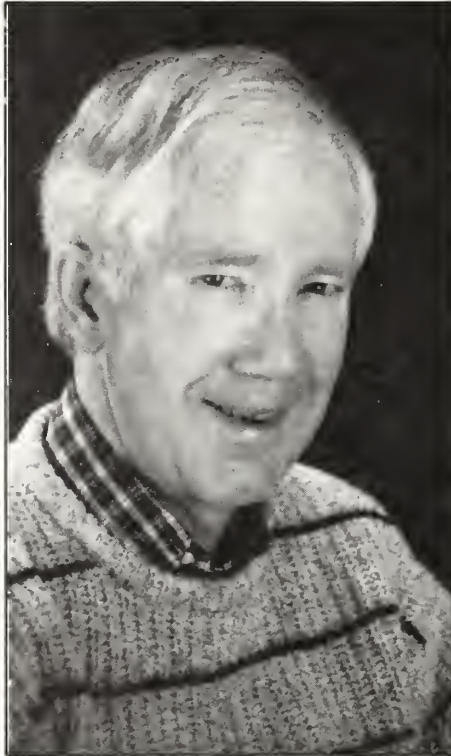
One of Schallau's surprise findings was that the forest products industry in the Mid-South resembles the industry in the Pacific Northwest.

Schallau should know. He has recently completed a study to find out how much timber-based employment and income has shifted from the Pacific Northwest to the South, and how the shift is related to such factors as industry composition, average wages, raw material costs, and productivity.

## Shift to south not uniform

Schallau expected to find that the industry had made gains in the South and had suffered losses in the Pacific Northwest. That was true, but he also found some surprises in the South. Gains in employment and earnings vary considerably among the southern States — and even within States — and much of the growth of the 1970's was confined to relatively few States. Another surprise was that in parts of the South the industry had suffered a decline similar to that of the Pacific Northwest.

The study illustrates the type of work Schallau undertakes in his job of examining the impact of forest management decisions on local communities and regions. Schallau heads a one-scientist research unit at the Station's Forestry Sciences Laboratory at Corvallis, Oregon. He works closely with forest economists at nearby Oregon State University and with other economists in universities around the country. One of his principal collaborators is Professor Wilbur Maki at the University of Minnesota.



*Economist Con Schallau*

"As far as I know, this was the first attempt to analyze the inter-regional employment and income effects of the changing forest products industry," Schallau says. "The study goes beyond counting noses within the industry. I wanted to find out how gains and losses affect communities whose economies depend on the industry."

In the recently completed study Schallau examined employment and earnings aspects of the timber economy shift. In a way, Schallau says, the study was an extension of an impact analysis he helped make in the late 1960's for the Douglas-fir supply study. That study was the first attempt to comprehensively examine the role of the timber industry in the economy of the Northwest.

In his study of the Northwest-South shift, Schallau analyzed employment and income information relevant to changes in the forest products industry of the two regions between 1970 and 1980, at local, State, and regional levels. The States studies were Oregon and Washington (the Pacific Northwest) and 13 southern States (Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Virginia, Tennessee, and Kentucky).

Schallau relied mainly on information from the U.S. Department of Commerce to examine the shift in employment and earnings. This information was also used to identify the industries that make up the economic base of State, sub-State, and regional areas. The economic base is composed of industries that export products and services beyond their boundaries and bring in "new" dollars from the outside world. Most manufacturing, including forest products, contributes to the economic base.

Study results indicate that between 1970 and 1975, growth in forest industry employment in the Pacific Northwest exceeded growth in the South. After 1975, however, growth continued in the South but decreased in the Pacific Northwest. To people familiar with economics and employment trends, the findings about the two regions were not unexpected. What was surprising to Schallau was the variation within the South.

## **Growth confined to few states**

Schallau had expected all the southern States to have a share of the region's growth. What he found, instead, was that much of the growth was confined to relatively few States. In North Carolina, for instance, the industry accounted for 38 percent of the region's employment growth between 1970 and 1980. Together, three other States — Texas, Alabama, and Virginia — accounted for an additional 38 percent of the gain. Seven of the other nine southern States shared the remainder of the region's growth. In Arkansas, however, industry employment remained constant, and Louisiana lost employment.

Another surprise was the change in shares of the Nation's total forest products industry. In 1980, the mid-South States of Arkansas, Louisiana, and Mississippi had a smaller share than they had in 1970 — quite in contrast to the rest of the region. "I did not expect the mid-South to be so different from the rest of the region," Schallau says, "Actually the mid-South bears a striking resemblance to the Pacific Northwest: during the 1970's both regions lost a share of the Nation's forest products employment."

Another factor Schallau studied was the dependency of States and regions on the timber industry. In some parts of the country, particularly in the Northwest, the National Forest System accounts for a growing share of the timber processed by the forest products industry. The Forest Service is committed to helping timber-dependant communities achieve economic stability. "This means that the agency's policies on forest land management are fashioned to avoid economic changes that might precipitate major job changes and related population losses," he says. "Part of my research mission is to provide information to help managers of public forests promote community stability."

Dependency on timber in the South is distinctly different from the dependency of the Northwest communities. In most non-metropolitan areas of the Northwest the forest products industry is the most important basic industry. "Without it," Schallau says, "many timber-dependent communities would cease to exist. In the South, however, most non-metropolitan areas are more diversified. Consequently, the growth of the industry in the South during the 1970's, although welcome, was not as noticeable as was the decrease in employment in the Northwest."

## Factors behind shift

Schallau says that a close look at factors behind the changes in the industry was important in his analysis, because what happens to the industry in the South has influenced, and will continue to influence, the economic vitality of forest-dependent communities in the Pacific Northwest.

Schallau has observed that several factors have contributed to the change in fortunes of the forest products industry in Oregon and Washington. The depletion of privately owned, old-growth timber and increasing competition for public timber are commonly cited. But there are other important reasons. In the South, the maturing of second-growth timber during the late 1960's gave rise to a new softwood plywood industry. This timber was on land that had been logged in the early 1900's and then reseeded or planted after it was no longer needed for growing cotton.

State-of-the-art logging and processing equipment, lower labor costs, and lower transportation costs gave the South's industry a competitive edge. Gradually the forest products industry in the Pacific Northwest — which traditionally had had little competition — lost most of its markets east of the Mississippi to southern producers.

An additional impact on the industry has come from Canada. Lower product prices, that result from increasingly favorable monetary exchange rates, and lower transportation costs, have allowed lumber mills in British Columbia to attract customers away from mills in Oregon and Washington. Most of these customers are in the South and East, but some are in the Pacific Northwest.

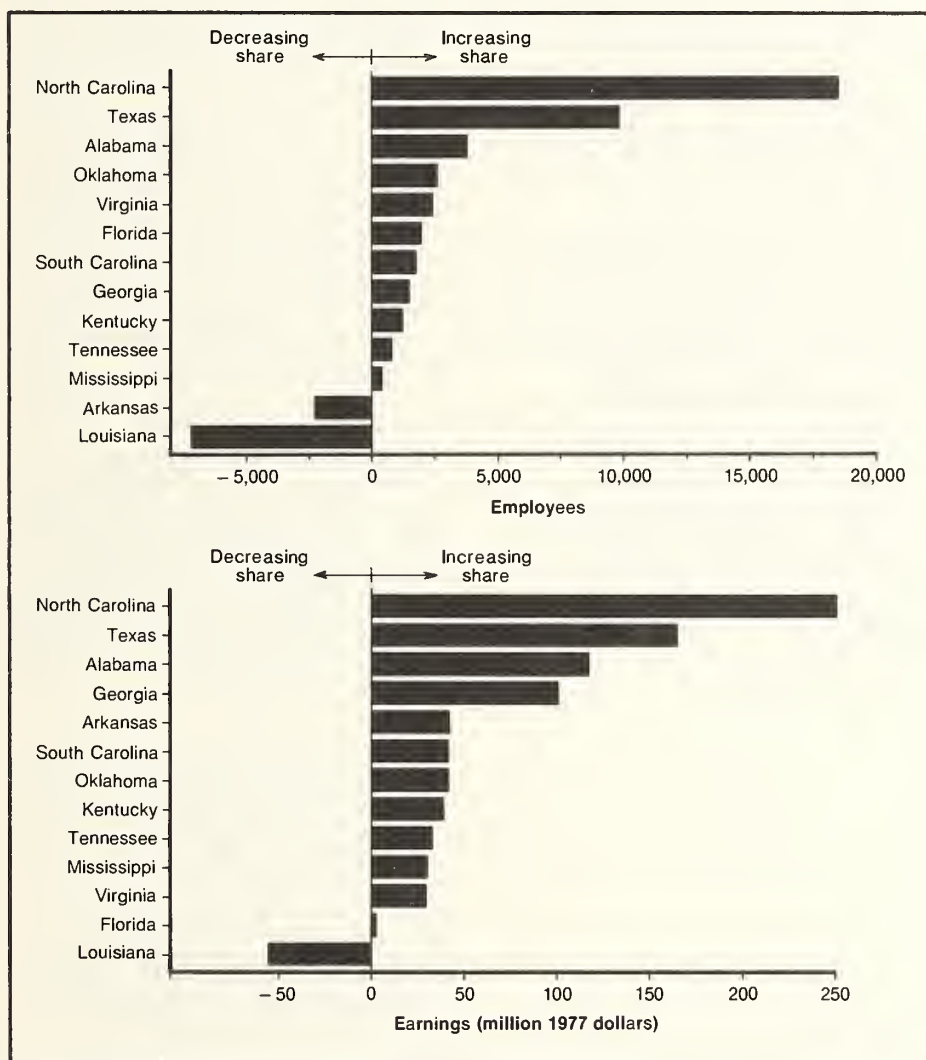
## Previous timber industry shifts

"This is not the first geographic shift of the timber industry," Schallau says. "In Colonial times, timber was harvested in the northeastern States for export as well as local needs." Timber harvesting proceeded westward to the Lake States. By the turn of the Century the virgin pine stands in Michigan, Wisconsin, and Minnesota were gone, so the forest products industry moved to the South and West. The South's old-growth pine was depleted by the mid-1920's, leaving the Pacific Northwest with the dominant role of producing timber products for national and international markets.

Little timber was harvested from public land in the Pacific Northwest until after 1950; private supplies were adequate to meet the needs of the region for raw material. But by the end of the 1960's many private owners had completed logging of their old growth and the industry and dependent communities began to rely increasingly on timber from public land.

The Pacific Northwest continued to dominate the Nation's softwood lumber and plywood markets, but the situation began to change during the 1970's. "The shift to the South was driven by the maturing of second-growth pine stands. The southern plywood industry, which did not exist, in 1960, led the phenomenal increase in softwood manufacturing capacity," Schallau says; "In addition, paper production capacity also was expanded and modernized. These shifts were accelerating as the supply of privately owned old-growth was diminishing in the Pacific Northwest."

Schallau expects continued and orderly growth of most timber-dependent economies in the South, but some in the Pacific Northwest could experience difficulty because of declining timber harvesting from private lands. "I hope my study will help public forest managers identify areas where their timber management policies can be modified to help communities achieve a more orderly adjustment to these changes," he says.



Not all southern states increased their share of the Nation's forest products industry earnings and employment between 1970 and 1980. For example, North Carolina's share of the Nation's employment increased by about 17,500, but Arkansas' share decreased by about 2,500.

Providing economic information that can help people who make forest management policy decisions — public and private, nationally and regionally — is Schallau's current research mission. Schallau returned to the Pacific Northwest Station in 1977 to head a regional economics research unit at the Station's Corvallis laboratory. He had first joined the Pacific Northwest Station in 1964, where his work covered a variety of subjects in addition to impact analyses. These included the timing of road construction, the allowable cut effect, and money flows from the commercial banking industry in timber-dependent communities. He was a project leader in Portland before joining the Intermountain Station in 1971, as Assistant Station Director and later Deputy Station Director. He began his Forest Service career in the Lake States, where he conducted numerous economic studies related to non-industrial private forest landowners.

Schallau's study of the industry shift has generated a large amount of information that varies in technical content. Results will be reported in a variety of research papers and journal articles. The first outlet for his findings will be separate reports on the industry in each of the 15 States studied. Collectively these will document the regional shift. The Georgia report was the first to be published. For copies of *Georgia's Forest Products Industry: Performance and Contribution to the State's Economy, 1970 to 1980*, By Wilbur R. Maki, Con H Schallau, Bennett B. Foster, and Clair Redmond, (Research Paper PNW-332), write the Pacific Northwest Station.

## Deer habitat in southeast Alaska described

New insight into the effects of logging on deer habitat in southeast Alaska comes from a report by Wildlife Biologist Tom Hanley at the Pacific Northwest Station. Quality of habitat for Sitka black-tailed deer in snowy winter ranges should be viewed as an energy benefit-cost relation, he says. As snow depth increases, the energy available to deer decreases because the best forage is covered with snow, other forage is less nutritious, and the deer must expend more energy to get it.

Hanley suggests that plans for deer habitat should be based on the relationships between canopy characteristics and the amount, quality, and availability of winter forage. These relationships vary with snow depth, however, and their dynamic nature is most important. Timber stands that contain large trees of varied ages generally allow more sunlight to reach understory vegetation during the growing season and intercept more snow during winter than do even-aged, second growth stands. Although clearcuts produce

more forage during the first 20 years, the forage is not available to deer when it is covered by snow. Closed-canopied, even-aged stands produce virtually no winter forage and persist through the normal rotation age of 100 years.

The current and projected increase in logging in southeastern Alaska, and the prospect that the amount of even-aged forest will increase in the future, is of major importance to forest managers concerned with deer habitat.

Copies of *Relationships Between Sitka Black-Tailed Deer and Their Habitat* by Thomas A. Hanley (General Technical Report PNW-168) are available from the Pacific Northwest Station.

## Planning for fire in wilderness

Before 1964, Federal agencies pursued a policy of total fire control. The Wilderness Act of 1964 spurred changes in philosophy. Now the notion that fire is a natural force with an important role in ecosystems is causing land managers to develop new management strategies relating to fire in Wilderness areas.

In a new report from the Intermountain Station's Northern Forest Fire Laboratory in Missoula, Montana, research forester William C. Fischer offers wilderness fire management planning guidelines. His report identifies fire management objectives, and then applies those objectives to wildfire or prescribed fire in Wilderness areas.

Because the field of wilderness fire management is relatively new, it lacks accepted terminology. The report suggests common terminology that is both logical and easy to understand.

For your copy of this report, request *Wilderness Fire Management Planning Guide*, General Technical Report INT-171, by William C. Fischer.

## Dwarf mistletoe symposium proceedings published

Proceedings are now available from a symposium on the biology of dwarf mistletoes (*Arceuthobium*), held at Colorado State University on August 8, 1984, in conjunction with the national meetings of the American Institute of Biological Sciences.

The symposium was organized by Frank G. Hawksworth, Rocky Mountain Station, and R.F. Scharpf, Pacific Southwest Station, and sponsored by the two stations, the Botanical Society of America, and the American Institute of Biological Sciences. The gathering addressed four broad topics on dwarf mistletoes:

- 1) BIOSYSTEMATICS, HOSTS, AND DISTRIBUTION — Recent taxonomic developments in the genus *Arceuthobium*; dwarf mistletoes in China; isozyme study of the dwarf mistletoes; and isozyme variation of two Colorado dwarf mistletoes in relation to their hosts.
- 2) PHYSIOLOGY, ANATOMY, RESISTANCE — Light and electron microscope studies of the morphology of the endophytic system; hormone relationship of mistletoes and hosts; a study of water relations and seedling photosynthesis; and host resistance to the dwarf mistletoes.

- 3) POPULATION DYNAMICS — Seed development, germination, and infection characteristics of *Arceuthobium*; pollination biology of a jack pine mistletoe in Manitoba, Canada; insect and mite associates with dwarf mistletoes; and long-distance mistletoe seed dispersal by birds and mammals.
- 4) ECOLOGY — Relationship between dwarf mistletoes and habitat types; changes in community structure and function resulting from dwarf mistletoe infection; and interrelationships between dwarf mistletoe and fire.

Copies of *Biology of Dwarf Mistletoes: Proceedings of the Symposium*, General Technical Report RM-111, are available from the Rocky Mountain Station.

## Habitat types classified for northern Utah area

Effective forest management requires a classification system that will accurately identify existing forest vegetation, as well as predict how vegetation may change over time.

A classification system of the various habitat types found in forests of northern Utah and adjacent areas in Idaho and Wyoming has been produced by cooperators of the Intermountain Station. The report results from 6 years of reconnaissance and is based on 1,100 sample stands. A total of 8 climax series, 36 habitat types, and 24 phases of habitat types are identified.

Land managers can use a diagnostic key contained in the report to identify a particular habitat type from indicator plant species.

The report also portrays the distribution of various forest communities, describes potential timber productivity, and highlights physical, climatic, and soil characteristics of habitat types. It describes implications of various management practices.

Request *Coniferous Forest Habitat Types of Northern Utah*, General Technical Report INT-170, by Ronald L. Mauk and Jan A. Henderson.

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## Inventory guidelines for advance regeneration

Advance regeneration, if properly managed, can help achieve a vigorous new stand after timber harvest. However, careful inventory of this stand component is an important first step toward successful management. Conventional stocking surveys often misrepresent the extent and quality of this resource.

Guidelines for inventorying advance regeneration have been developed by Dennis Ferguson, research forester at the Intermountain Station's Forestry Science Lab in Moscow, Idaho. His research note, *Needed: Guidelines for Defining Acceptable Advance Regeneration*, suggests criteria for establishing guidelines for both preharvest and postharvest inventories. Request Research Note INT-341.

## Computer program helps analyze timber management policies

If you want to analyze the long-term economic and demographic effects of forest management policies, you can get help from a new computer program called IPASS. Its data base includes statistics on employment, population, earnings, productivity, and output, plus annual rates of change for a number of variables, such as birth rates and hours worked per week. Using the data base and information on historical rates of change, IPASS will simulate the growth and development of an economy for a specified period.

The program is interactive, meaning that you can introduce changes based on varying assumptions about population, employment, earnings, and investment to produce different forecasts, which can then be compared. No previous experience in programming or model building is necessary to use the program.

A new publication describes the model in enough detail that you can decide whether it will be useful. For copies of *IPASS: An Interactive Policy Analysis Simulation System*, by Doug Olson, Con Schallau, and Wilbur Maki (General Technical Report PNW-170), write to the Pacific Northwest Station.

## Test results of fireline blasted with explosives

Explosives have long been considered a possible tool for fireline construction. Unfortunately, little information has been available to compare the quality and the cost of blasted fireline to conventional methods such as hand crews or bulldozers.

Research Forester Richard J. Barney at the Intermountain Station's Northern Forest Fire Lab in Missoula, Montana, describes characteristics of blasted fireline in a recent study. Two types of linear explosives were compared in heavy, moderate, and light fuel cover. Barney found slight differences between the two explosives, but concludes that both can create, after light cleanup, effective firebreaks.

Future research will assess characteristics of blasted fireline in other cover types, and provide cost comparisons between blasting versus conventional construction methods.

If you would like more information on this study, request *Characteristics of Fireline Blasted with Linear Explosives: Initial Test Results*, Research Note INT-345.

## Determining wildland values

A book has just been published that provides a comprehensive review of the most advanced techniques in the valuation of wildland benefits.

Roughly two-thirds of the U.S. is wildland — land not used for industrial, urban, or agricultural purposes. How can a price tag be put on this vast resource? What concrete value can be placed on an asset that provides almost limitless tangible and intangible benefits? These questions are gaining widespread attention as pressures on U.S. wildlands reach critical levels, and debate over their proposed uses and costs grow.

This book, *Valuation of Wildland Resource Benefits*, published in cooperation with the Rocky Mountain Station, discusses concepts, methods, and problems in wildland benefit valuation, offering critical perspectives on the role of benefit-cost analysis as a decision-making tool in developing public land policy.

Copies of the 260-page hardcover report are available at \$25.00 per copy from Westview Press, Inc., 5500 Central Avenue, Boulder, Colorado 80301.

GPO 846-213

Please send the following Pacific Northwest Station publications:

- ☐ *The Value of Roaded, Multiple-use Areas as Recreation Sites in Three National Forests of the Pacific Northwest*, Research Paper PNW-319
- ☐ *IPASS: An Interactive Policy Analysis Simulation System*, General Technical Report PNW-170
- ☐ *Relationship Between Sitka Black-tailed Deer and their Habitat*, General Technical Report PNW-168
- ☐ *Georgia's Forest Products Industry: Performance and Contribution to the State's Economy, 1970 to 1980*, Research Paper PNW-332
- ☐ Other \_\_\_\_\_

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Please send the following Intermountain Station publications:

- ☐ *Characteristics of Fireline Blasted with Linear Explosives*, Research Note INT-345
- ☐ *Needed Guidelines for Defining Acceptable Advance Regeneration*, Research Note INT-341
- ☐ *Wilderness Fire Management Planning Guide*, General Technical Report INT-171
- ☐ *Coniferous Forest Habitat Types of Northern Utah*, General Technical Report INT-170
- ☐ Other \_\_\_\_\_

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Please send the following Rocky Mountain Station publications:

- ☐ *Options for Harvesting Timber to Control Snowpack Accumulation*, a reprint
- ☐ *Biology of Dwarf Mistletoes: Proceedings of the Symposium*, General Technical Report RM-111
- ☐ *The Concept of Value in Resource Allocation*, a reprint
- ☐ *Empirical Estimates of Amenity Forest Values: A Comparative Review*, General Technical Report RM-107
- ☐ Other \_\_\_\_\_

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